Hospice Enrollment, Local Hospice Utilization Patterns, and Rehospitalization in Medicare Patients

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Abstract

Background: Rehospitalizations are prevalent and associated with decreased quality of life. Although hospice has been advocated to reduce rehospitalizations, it is not known how area-level hospice utilization patterns affect rehospitalization risk.

Objectives: The study objective was to examine the association between hospice enrollment, local hospice utilization patterns, and 30-day rehospitalization in Medicare patients.

Methods: With a retrospective cohort design, 1,997,506 hospitalizations were assessed between 2005 and 2009 from a 5% national sample of Medicare beneficiaries. Local hospice utilization was defined using tertiles representing the percentage of all deaths occurring in hospice within each Hospital Service Area (HSA). Cox proportional hazard models were used to assess the relationship between 30-day rehospitalization, hospice enrollment, and local hospice utilization, adjusting for patient sociodemographics, medical history, and hospital characteristics.

Results: Rates of patients dying in hospice were 27% in the lowest hospice utilization tertile, 41% in the middle tertile, and 53% in the highest tertile. Patients enrolled in hospice had lower rates of 30-day rehospitalization than those not enrolled (2.2% versus 18.8%; adjusted hazard ratio [HR], 0.12; 95% confidence interval [CI], 0.118–0.131). Patients residing in areas of low hospice utilization were at greater rehospitalization risk than those residing in areas of high utilization (19.1% versus 17.5%; HR, 1.05; 95% CI, 1.04–1.06), which persisted beyond that accounted for by individual hospice enrollment.

Conclusions: Area-level hospice utilization is inversely proportional to rehospitalization rates. This relationship is not fully explained by direct hospice enrollment, and may reflect a spillover effect of the benefits of hospice extending to nonenrollees.

Introduction

DESPITE INCREASING HOSPICE UTILIZATION, care at the end of life continues to be defined by high-cost, high-intensity interventions, and multiple transitions of care that include frequent hospitalizations.^{1–7} These admissions often lead to frequent cycling in and out of the hospital, with approximately 20% of all Medicare beneficiaries being rehospitalized within 30 days of discharge.⁸ Rehospitalizations in this patient population are associated with a diminished quality of life, and are often incongruent with the wishes of terminally ill patients, leading to a misalignment of patient expectation and care delivery.^{9–13}

Rehospitalizations are now a core quality measure for the Center for Medicare and Medicaid Services (CMS), with recently implemented financial penalties for hospitals with unacceptably high rates. Because rehospitalizations are at direct odds with the goals of hospice care, there is a growing interest in the potential role for hospice and palliative care in reducing rehospitalizations at the end of life. Hospice enrollment has previously been shown to decrease the risk of hospitalization and rehospitalization, although not in a national sample.^{4,14–18}

There has been a rapid, but uneven, expansion in hospice capacity and utilization across the United States over the last decade. Between 2000 and 2011 there was a 2.1% average

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annual rise in hospice utilization, and a 59% increase in the total number of hospices.¹⁹ This growth is not uniform across the country, however, and there is geographic variation in hospice utilization at the end of life that is unrelated to patient preferences, demographics, financial viability, or capacity constraints.^{7,20–29} Hospice enrollment decisions are individualized, complex, and influenced by multiple locally dependent systems of care and practice patterns, such as patient and physician treatment preferences, ancillary support structures, and area resource availability. Consequently, hospice enrollment, and any moderating effect that hospice enrollment patterns have on rehospitalization risk, is likely dependent on local systems of care and practice norms. However, it is not known how individual hospice enrollment and area-level hospice utilization patterns affect rehospitalization risk.

The objective of this study was to examine the association between hospice enrollment, local hospice utilization patterns, and 30-day rehospitalization rates in Medicare patients. We hypothesized that local hospice utilization patterns would impact the risk of rehospitalization directly through individual patient-level hospice enrollment, and indirectly through local systems of care and practice patterns.

Methods

Data sources

We utilized a 5% random national sample of Medicare beneficiaries from January 1, 2004 to December 31, 2009 obtained through the CMS Chronic Condition Data Warehouse. Medicare enrollment and claims data were linked by patients' zip code of residence to 2000 U.S. Census data and to Hospital Service Area (HSA), obtained through the *Dartmouth Atlas*.³⁰ HSAs are representative of the geographic areas served primarily by individual acute care hospitals.

Study sample

We identified for initial inclusion in the study sample Medicare fee-for-service beneficiaries 65 years of age or older discharged from an acute care hospitalization between January 1, 2005 and December 1, 2009. Eligible patients had continuous enrollment in Medicare Parts A and B for the 12 months preceding the index hospitalization (to obtain baseline characteristics)—and with survivors, for 30 days postdischarge (to assess the primary outcome of 30-day rehospitalization). Patients were excluded who were (1) enrolled in a health maintenance organization (HMO), (2) discharged against medical advice, (3) railroad beneficiaries; or who died during the index stay. The initial study sample included 2,331,738 index hospitalizations. Those already enrolled in hospice at the time of admission to the index hospitalization were excluded in order to isolate the effect of new hospice enrollment on 30-day rehospitalization risk (28,452 observations). Lastly, patients who lived in HSAs with less than 20 total deaths were excluded (278,076 observations). This was done to stabilize the estimates of local hospice utilization, which in sparsely populated areas were sensitive to small changes in the number of hospice enrollees in the numerator and the total number of deaths in the denominator.

Patients could contribute more than one index hospitalization to the sample. We chose to take this approach to ad-

equately represent frequently hospitalized patients, who are the major drivers of hospital-based care and resource utilization at the end of life. Also, from a policy perspective, patients with recurrent hospitalizations are the primary intervention targets for reducing rehospitalizations. Additionally, the CMS rehospitalization metric counts each rehospitalization when assessing hospital performance. The final data set included 1,997,506 index hospitalizations. The institutional review board from the University of Wisconsin approved this study.

Variables

The primary explanatory variables were local hospice utilization and hospice enrollment. Local hospice utilization, previously defined by Givens et al. as the proportion of deaths in each HSA that occurred while the patient was enrolled in hospice, reflects regional patterns of hospice utilization.³¹ We used data from the years 2005 to 2009 to calculate the local hospice utilization for each HSA, and then grouped the spectrum of values into tertiles representing high, medium, and low hospice utilization areas. We defined 30-day hospice enrollment as the presence of at least one Medicare hospice claim within 30 days after the index hospitalization admission date.

Patient sociodemographic characteristics included categorical variables of age, gender, race, and Medicaid enrollment, and continuous variables of neighborhood education and income. We approximated patient income and education using census block group data from the 2000 U.S. Census. Education was defined as the percentage of adults ≥ 25 years of age who had graduated high school within the patient's census block group, and income was defined as the percentage of families living below the federal poverty level.

Patient-level medical history and comorbidities included categorical variables of CMS Hierarchical Condition Categories (HCC) scores, Elixhauser comorbidities, number of hospitalizations in the 12-month period prior to the index hospitalization, duration of the index hospitalization, nursing home stay within 30 days prior to the index hospitalization, and disability as the original reason for Medicare entitlement. The HCC score is an adjustment measure that CMS uses to modify prospective capitation payments.³² There are 70 condition categories that are weighted to give a single composite risk score with a mean of 1.0. Elixhauser comorbidities are a set of 30 comorbidities associated with hospital lengths of stay and health care costs.³³ We calculated the HCC score and identified each Elixhauser comorbidity from all hospital and physician claims from the 12-month period prior to the index hospitalization. Comorbidities with a prevalence of over 5% in our sample were included as separate indicator variables, and the remaining comorbidities were collapsed into an "any other" category and included alcohol abuse, chronic blood loss anemia, drug abuse, liver disease, lymphoma, paralysis, peptic ulcer disease with bleeding, psychoses, and rheumatoid arthritis/collagen vascular disease.

Index hospital characteristics included categorical variables of the average annual discharge count, medical school affiliation, Rural/Urban Commuting Area Code (RUCA), and critical access designation. We calculated the mean discharge volume using acute care claims for each individual facility between 2004 and 2009. RUCA codes represent rural/urban

gradients of census tracts and are categorized as urban core, suburban, large town, and small town or isolated rural areas.³⁴

The primary outcome variable was all-cause rehospitalization within 30 days of discharge from the index hospitalization. We constructed the variable based on the criteria CMS uses for the rehospitalization quality metrics.^{35–37} We excluded rehospitalization claims for same-day readmission to the discharging hospital for the same condition. Only one admission was counted as a rehospitalization if there were multiple hospitalizations within the 30-day period following discharge. As in the CMS measures, transfers to other acute care facilities were considered single episodes of care. We defined the primary rehospitalization diagnosis from single-level diagnostic categories using the Agency for Healthcare Research and Quality's Clinical Classifications Software.

Statistical analyses

We described patient sociodemographics, medical history, and index hospital characteristics both overall and stratified by high, medium, and low local hospice utilization. We assessed differences between categorical variables using Pearson's chi-square tests, and one-way analysis of variance tests for continuous variables.

We used Cox proportional hazard models to assess the relationship between 30-day rehospitalization, local hospice utilization, and hospice enrollment. Censoring was defined at the first occurrence of the cause-specific outcomes of rehospitalization or death, or at 30 days if neither outcome occurred. Multivariate regressions modeled 30-day rehospitalization as a function of age, gender, race, Medicaid enrollment, education, income, HCC score, Elixhauser comorbidities, duration of index hospitalization, nursing home stay within 30 days of hospitalization, disability, mean annual discharge volume of the index hospital, medical school affiliation, hospital RUCA, and critical access designation. We additionally performed multivariate regressions stratified by the number of hospitalizations in the preceding 12 months of the index hospitalization in order to assess the effect of prior hospital utilization on the association of 30-day rehospitalization, local hospice utilization, and hospice enrollment. Clustered standard errors were calculated in all analyses to account for repeat index hospitalizations.

Because the Cox model assumes noninformative censoring, which may not hold regarding the potentially correlated outcomes of rehospitalization and death, we performed a competing risks survival analysis using the Fine & Gray method as a sensitivity analysis.³⁸ This model estimates the cumulative probability of rehospitalization within 30 days in the presence of the competing risk of death using cumulative incidence functions. A second sensitivity analysis using discrete time survival analysis modeled each day in the 30-day posthospitalization period as a separate indicator variable. Because hospice enrollees could enroll at any time within 30 days of the hospital admission date, the discrete time analysis modeled time-varying hospice enrollment to assess whether the Cox model overestimated the effect size of hospice enrollment on 30-day rehospitalization risk. This was only done on the data stratified by prior hospitalizations due to the large sample size.

Statistical analyses were performed using SAS (SAS version 9.3; SAS Institute Inc., Cary, NC) and Stata (Stata version 12.0; StataCorp, College Station, TX). All *p*-values are two-sided and considered significant at the 5% level.

Results

Characteristics of the hospitalized patients and index hospitals, both overall and stratified by local hospice utilization, are described in Table 1. The average age was 78.8 years, 63% were female, and 87% were white. Overall, 40% of patients died in hospice care, averaging 27% in low hospice utilization areas, 41% in medium utilization areas, and 53% in high utilization areas. The map in Figure 1 illustrates the significant variation in local hospice utilization across the country. Patients enrolled in hospice an average of 10.3 days after hospital admission, which was similar across hospice utilization areas. High hospice utilization areas had a lower average hospice length of stay of 46 days compared to medium and low utilization areas of 55 days and 58 days, respectively.

Overall, 18.2% of patients were rehospitalized within 30 days of discharge. The rehospitalization rates varied across local hospice utilization areas, with 19.1% of patients rehospitalized in low utilization areas, 18.1% in medium utilization areas, and 17.5% in high utilization areas ($p < 0.001$). Low hospice utilization areas tended to have a higher proportion of nonwhite patients, Medicaid enrollees, and neighborhoods with lower education and income levels. Comorbidities were similar across areas. Hospitals in low hospice utilization areas tended to be smaller and more rural compared to hospitals in high utilization areas.

Hospice enrollment

Hospice enrollment within 30 days of hospital admission was associated with a reduced risk of rehospitalization (adjusted hazard ratio [HR], 0.12; 95% confidence interval [CI], 0.118–0.131). The survival curves in Figure 2 demonstrate the unadjusted proportion of both hospice enrollees and nonenrollees who remained out of the hospital in the 30-day posthospitalization period. At 30 days, 2.2% of patients enrolled in hospice were rehospitalized, compared to 18.8% of nonenrollees. The rehospitalization diagnoses were similar between hospice enrollees and nonenrollees, with the three most prevalent diagnoses of sepsis, congestive heart failure, and pneumonia being the same (see Appendix Table 1, which lists the 10 most prevalent diagnoses for rehospitalization).

Local hospice utilization

Compared to high hospice utilization areas, patients in medium and low utilization areas were at 1% and 5% increased risk for rehospitalization, respectively, adjusting for patient sociodemographics, medical history, and index hospital characteristics (see Table 2, Model 1; Appendix Table 2 presents the results of the full model with covariates). The effect of hospice enrollment in reducing rehospitalization risk remained constant regardless of a patient's number of prior hospitalizations (see Table 3). Furthermore, the risk reduction did not substantially change with time-varying hospice enrollment in the discrete time sensitivity analysis.

Area hospice utilization had an effect on 30-day rehospitalization beyond that of direct hospice enrollment. The

TABLE 1. CHARACTERISTICS OF MEDICARE BENEFICIARIES HOSPITALIZED IN 2005–2009, OVERALL AND BY TERTILE OF LOCAL HOSPICE UTILIZATION^{c,*}

<i>Characteristic</i>	<i>Overall^{a,b}</i> (N = 1,997,506)	<i>High^{a,b}</i> (N = 665,176)	<i>Medium^{a,b}</i> (N = 664,445)	<i>Low^{a,b}</i> (N = 667,885)
Local hospice utilization, % (SD)	40 (12)	53 (5.9)	41 (3.1)	27 (6.5)
<i>30-day patient outcomes</i>				
Rehospitalization	18.2	17.5	18.1	19.1
Mortality	6.0	6.3	6.0	5.8
Hospice enrollment	4.3	5.6	4.3	2.9
<i>Patient sociodemographic characteristics</i>				
Age, mean (SD)	79 (7.8)	79 (7.8)	79 (7.8)	79 (7.8)
65–69 years	14	14	15	14
70–74 years	19	19	19	18
75–79 years	21	21	21	21
80–84 years	21	21	21	21
≥ 85 years	25	25	24	25
Gender				
Male	37	37	37	37
Female	63	63	63	63
Race				
White	87	91	86	83
Black	9.3	6.4	10	11
Other	4.0	2.9	3.5	5.6
Medicaid enrollment	19	15	19	24
Percentage of adults age ≥ 25 with at least a high school diploma in patient's census block group ^d	81 (13)	83 (12)	81 (13)	79 (14)
Percentage below poverty level in patient's census block group ^d	8.1 (9.5)	6.8 (8.0)	8.0 (9.4)	9.4 (11)
<i>Patient medical history</i>				
Community HCC score prior to hospitalization, mean (SD)	2.5 (1.9)	2.5 (1.8)	2.5 (1.9)	2.6 (1.9)
1st quartile (mean = 0.75)	25	26	25	24
2nd quartile (mean = 1.56)	25	25	25	25
3rd quartile (mean = 2.67)	25	25	25	25
4th quartile (mean = 5.15)	25	24	25	26
<i>Elixhauser comorbidities</i>				
Hypertension	56	58	56	56
Fluid and electrolyte disorders	33	35	33	32
Chronic pulmonary disease	28	29	28	28
Congestive heart failure	28	27	28	28
Deficiency anemias	25	25	25	25
Any other ^c	20	20	20	19
Diabetes without complications	15	15	15	15
Valvular disease	15	16	15	14
Hypothyroidism	15	16	15	14
Renal failure	14	15	14	14
Peripheral vascular disease	14	14	14	13
Other neurological disorders	12	12	12	12
Depression	12	12	12	11
Diabetes with complications	8.9	8.7	8.8	9.2
Obesity	6.5	7.0	6.6	6.1
Pulmonary circulation disease	6.2	6.8	6.2	5.5
Weight loss	6.1	6.5	6.4	5.5
Solid tumor without metastasis	6.0	6.1	6.1	5.7
Coagulopathy	5.5	5.9	5.5	5.0
Metastatic cancer	3.4	3.4	3.5	3.5
Number of hospitalizations in previous 12 months, mean (SD)	1.1 (1.6)	1.1 (1.6)	1.1 (1.6)	1.2 (1.7)
0	48	49	48	47
1	25	25	25	25
2	13	12	13	13
≥ 3	14	13	14	15

(continued)

TABLE 1. (CONTINUED)

<i>Characteristic</i>	<i>Overall^{a,b}</i> (N = 1,997,506)	<i>High^{a,b}</i> (N = 665,176)	<i>Medium^{a,b}</i> (N = 664,445)	<i>Low^{a,b}</i> (N = 667,885)
Duration of index hospitalization (days), mean (SD)	5.2 (5.3)	5.0 (4.8)	5.2 (5.2)	5.5 (5.8)
0–2 days	28	28	28	27
3–4 days	31	32	31	30
5–6 days	17	17	17	17
≥ 7 days	24	23	24	26
Nursing home stay within 30 days prior to index hospitalization	10	9.4	10	11
Presence of a disability	2.3	2.5	2.4	2.0
<i>Index hospital characteristics</i>				
Average annual total discharge count, mean (SD)	7716 (5280)	8052 (5823)	7916 (5073)	7181 (4855)
> 10,000 annual discharges	25	26	27	21
7001–10,000 annual discharges	20	22	21	18
4001–7000 annual discharges	31	30	29	33
≤ 4000 annual discharges	24	22	22	28
<i>Medical school affiliation</i>				
None	52	60	49	47
Minor	24	21	27	24
Major	24	20	24	29
<i>RUCA</i>				
Urban core area	87	91	89	80
Suburban area	1.7	2.2	1.4	1.4
Large town area	10	5.5	9.0	16
Small town and isolated rural area	1.5	1.1	1.1	2.0
Critical access hospital	0.5	0.4	0.4	0.5

HCC, Hierarchical Condition Categories; RUCA, Rural/Urban Commuting Area Code; SD, standard deviation.

^aAll values are percentages unless specified.

^bPercentages may not sum to 100 due to rounding.

*All *p*-values are <0.001 except neurological disorders (0.90) and metastatic cancer (0.003).

^cLocal hospice utilization is defined as the percentage of patients that died who had entered into hospice care within each Hospice Service Area. See text for details.

^dCensus block group from the 2000 U.S. Census.

^eIncludes alcohol abuse, chronic blood loss anemia, drug abuse, liver disease, lymphoma, paralysis, peptic ulcer disease with bleeding, psychoses, rheumatoid arthritis/collagen vascular disease.

FIG. 1. Map of hospice utilization tertiles across Hospital Service Areas (HSAs) demonstrating local variation in hospice utilization patterns in the years 2004–2009.

FIG. 2. Kaplan-Meier survival curves for hospice enrollees and non-enrollees demonstrating the proportion of patients remaining out of the hospital in the 30-day post-discharge period.

residual effect of local hospice utilization rates on rehospitalization risk that is not explained by patient-level hospice enrollment was estimated by adding controls for individual hospice enrollment in Model 1, which resulted in a slight attenuation of the effect size in low hospice utilization areas (see Table 2, Model 2; Appendix Table 3 presents the results of the full model with covariates). This residual local effect of hospice utilization was stronger for patients with two or more previous hospitalizations (see Table 3). These patients had greater chronic disease burden and higher intensity of hospital care, as evidenced by average HCC scores of 4.33, a higher prevalence of comorbidities, and longer hospital lengths of stay. The sensitivity analysis using the Fine & Gray proportional hazards method to model death as a competing risk of rehospitalization did not substantially change the results, suggesting that areas with greater 30-day mortality rates were not falsely lowering rehospitalization rates by reducing the pool of at-risk patients (see Appendix Table 4).

Discussion

In summary, patients who were newly enrolled in hospice during or soon after hospitalization were at very low risk for

rehospitalization within 30 days of discharge, consistent with the goals of hospice care. In areas with high hospice utilization, there was an additional effect on rehospitalization beyond that accounted for by patient-level hospice enrollment. Lastly, there was wide geographic variation in local hospice utilization patterns at the end of life, ranging from 27% in low utilization areas to 53% in high utilization areas between the years 2005 and 2009.

The results presented here suggest that hospice care is associated with a large reduction in the risk for rehospitalization soon after enrollment and independent of a patient's prior intensity of hospital use. The high-intensity care provided through recurrent hospitalizations at the end of life reduces patient quality of life, patient and family satisfaction, and the likelihood of dying at home.^{9–11,25,39} Although the majority of individuals with terminal illness prefer comfort-focused care at home, their care preferences are commonly not discussed or followed.^{12,13,40,41} Hospice, by providing comprehensive patient- and family-centered care for seriously ill patients nearing the end of life, facilitates a transition to primarily home-based, holistic care focused on comfort and quality of life that is personalized to the individual patient's goals of care. Hospice additionally provides an immediate and always accessible on-call service for symptom

TABLE 2. COX PROPORTIONAL HAZARD MODELS WITH 30-DAY REHOSPITALIZATION AS A FUNCTION OF LOCAL HOSPICE UTILIZATION (MODEL 1) AND AS A FUNCTION OF LOCAL HOSPICE UTILIZATION AND INDIVIDUAL HOSPICE ENROLLMENT (MODEL 2), ADJUSTED FOR PATIENT CHARACTERISTICS, MEDICAL HISTORY, AND INDEX HOSPITAL CHARACTERISTICS^a (N=1,725,043)

Characteristic	Model 1		Model 2	
	Adjusted HR (95% CI)	P-value	Adjusted HR (95% CI)	P-value
Local hospice utilization				
High	1 (Reference)		1 (Reference)	
Medium	1.01 (1.00, 1.02)	0.004	1.01 (1.00, 1.02)	0.120
Low	1.05 (1.04, 1.06)	<0.001	1.04 (1.03, 1.05)	<0.001
Hospice enrollment	-	-	0.12 (0.118, 0.132)	<0.001

CI, confidence interval; HR, hazard ratio.

^aAdjusted for age, gender, race, Medicaid enrollment, percentage of adults age ≥ 25 with at least a high school diploma in patient's census block group, percentage below poverty level in patient's census block group, community HCC score, Elixhauser comorbidities, duration of index hospitalization, nursing home stay within 30 days prior to hospitalization, presence of disability, average annual hospital discharge count, medical school affiliation, RUCA, and critical access hospital.

TABLE 3. RELATIONSHIP BETWEEN HOSPICE ENROLLMENT, LOCAL HOSPICE UTILIZATION, AND 30-DAY REHOSPITALIZATION, STRATIFIED BY THE NUMBER OF HOSPITALIZATIONS IN THE PREVIOUS 12-MONTH PERIOD^a

<i>Characteristic</i>	<i>Adjusted HR (95% CI)</i>	<i>P-value</i>
No hospitalizations in the previous 12 months (N = 826,530)		
Local hospice utilization		
High	1 (Reference)	
Medium	1.00 (0.98, 1.01)	0.56
Low	1.01 (1.00, 1.03)	0.14
Hospice enrollment	0.11 (0.10, 0.12)	<0.001
One hospitalization in the previous 12 months (N = 436,647)		
Local hospice utilization		
High	1 (Reference)	
Medium	1.01 (0.99, 1.03)	0.23
Low	1.02 (1.00, 1.03)	0.09
Hospice enrollment	0.14 (0.12, 0.15)	<0.001
Two or more hospitalizations in the previous 12 months (N = 461,866)		
Local hospice utilization		
High	1 (Reference)	
Medium	1.01 (0.99, 1.02)	0.410
Low	1.05 (1.03, 1.07)	<0.001
Hospice enrollment	0.13 (0.12, 0.14)	<0.001

CI, confidence interval; HR, hazard ratio.

^aAdjusted for age, gender, race, Medicaid enrollment, percentage of adults age ≥ 25 with at least a high school diploma in patient's census block group, percentage below poverty level in patient's census block group, community HCC score, Elixhauser comorbidities, duration of index hospitalization, nursing home stay within 30 days prior to hospitalization, presence of disability, average annual hospital discharge count, medical school affiliation, RUCA, and critical access hospital.

management and acute changes in status that may preclude emergency medical services activation, emergency department evaluation, or rehospitalization. This realignment of care expectations and modal delivery helps reduce unwanted and burdensome rehospitalizations. Hospitalizations, therefore, represent a critically important point where discussions of care preferences can take place, and where transitions to hospice may improve the quality of care for select patients for whom hospice is consistent with their overall goals.

In terms of rehospitalization, local hospice utilization's effects are not completely explained by differing mortality or hospice enrollment rates. It is possible that the residual effects of local hospice utilization could potentially reflect an area's resources. Low hospice utilization areas may have limited community resources, which affect the quality of posthospital and transitional care processes and the availability of social supports. Although we attempted to control for surrogate measures of area resources, there may be residual confounding that impacted rehospitalization risk. Alternatively, the residual effects of local hospice utilization on rehospitalization risk may represent a spillover effect, in which the effects of hospice in high use areas move beyond individual enrollees to impact the care of those not actually enrolled in the hospice program. A hospice spillover effect has been observed in the nursing home setting, with family

members of hospice users, and on patterns of chemotherapy use at the end of life.^{6,15,42}

There are multiple mechanisms that may mediate such a spillover effect. Local hospice utilization patterns may be associated with provider decision making, care setting choice, care continuity, coordination and intensity, and the timing and frequency of advance care planning. In addition, areas with higher hospice utilization may have an increased awareness and use of palliative and hospice care for aggressive symptom control, family and caregiver support, and early recognition and management of posthospital complications. All of these care practices have been shown to reduce the intensity of care, lower hospitalization rates, and promote patient-centered care at the end of life.^{9,12,43–46}

There are several limitations to this study. We could not directly measure the local systems of care, area resources, patient preferences, or practice patterns that may mediate the effects seen in this study. Therefore, we were unable to determine the causal relationship between local hospice utilization patterns and rehospitalization rates within HSAs. There were also no measurements of hospice care delivery. The presence of inpatient palliative care services could not be ascertained, which may represent a potential mechanism by which local hospice utilization affects rehospitalization risk. Additionally, readmission to an inpatient hospice unit could not be determined. This study was limited to Medicare fee-for-service and may not be generalizable to HMO beneficiaries, who tend to have higher hospice utilization rates.^{19,47} Another limitation is that 508 of the 3346 HSAs were excluded from the study sample, because they had less than 20 total deaths between 2005 and 2009. This conservative approach was taken to improve the stability of the local hospice utilization estimates, although it highlights the lack of information and need for further study of the care delivery and utilization of hospice services in these sparsely populated areas.

In summary, despite the increasing rates of hospice enrollment, marked geographic variation in hospice utilization remains. This work suggests that hospice services are of benefit to both hospice enrollees as well as nonenrollees, especially in high hospice utilization areas, and may be an important component in efforts to improve posthospital care.

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APPENDIX TABLE 1. 10 MOST PREVALENT DIAGNOSES FOR REHOSPITALIZATION, STRATIFIED BY HOSPICE ENROLLMENT^a

Enrolled in hospice (N=1529)	Percentage	Not enrolled in hospice (N=362,312)	Percentage
Septicemia	7.5	Congestive heart failure (nonhypertensive)	8.9
Congestive heart failure (nonhypertensive)	6.9	Septicemia	5.5
Pneumonia ^b	5.6	Pneumonia ^b	4.8
Secondary malignancies	4.0	Surgical complication	3.9
Fluid and electrolyte disorders	3.9	Cardiac dysrhythmias	3.7
Respiratory failure	3.7	Chronic obstructive pulmonary disease	3.2
Aspiration pneumonitis	3.6	Device complication ^d	3.1
Acute/unspecified renal failure	3.3	Urinary tract infection	2.9
Hip fracture ^c	3.2	Acute/unspecified renal failure	2.9
Urinary tract infection	3.1	Fluid and electrolyte disorders	2.8

^aThe Agency for Healthcare Research and Quality's Clinical Classification Software single code and classification applied to principal diagnosis of rehospitalization.

^bExcept that caused by tuberculosis or sexually transmitted disease.

^cFracture of the neck of the femur.

^dImplant or graft.

APPENDIX TABLE 2. RELATIONSHIP BETWEEN LOCAL HOSPICE UTILIZATION AND 30-DAY REHOSPITALIZATION, ADJUSTED FOR PATIENT CHARACTERISTICS, MEDICAL HISTORY, AND INDEX HOSPITAL CHARACTERISTICS (N=1,725,043)

<i>Characteristic</i>	<i>Adjusted HR (95% CI)</i>	<i>P-value</i>
Local hospice utilization ^a		
High	1 (Reference)	
Medium	1.01 (1, 1.02)	0.0040
Low	1.05 (1.04, 1.06)	<0.0001
<i>Patient sociodemographic characteristics</i>		
Age, mean (SD)		
65–69 years	1 (Reference)	
70–74 years	1 (0.98, 1.02)	0.87
75–79 years	1.01 (0.99, 1.02)	0.38
80–84 years	1.02 (1.01, 1.04)	0.003
≥85 years	1.03 (1.01, 1.04)	0.001
Gender		
Male	1 (Reference)	
Female	0.93 (0.92, 0.94)	<0.0001
Race		
White	1 (Reference)	
Black	1.07 (1.05, 1.09)	<0.0001
Other	0.99 (0.97, 1.01)	0.40
Medicaid enrollment	1 (0.99, 1.01)	0.91
Percentage of adults age ≥25 with at least a high school diploma in patient's census block group ^b	0.85 (0.82, 0.89)	<0.0001
Percentage below poverty level in patient's census block group ^b	1 (0.95, 1.06)	0.930
<i>Patient medical history</i>		
Community HCC score prior to hospitalization, mean (SD)		
1st quartile (mean=0.75)	1 (Reference)	
2nd quartile (mean=1.56)	1.3 (1.28, 1.32)	<0.0001
3rd quartile (mean=2.67)	1.57 (1.55, 1.59)	<0.0001
4th quartile (mean=5.15)	1.92 (1.89, 1.95)	<0.0001
Elixhauser comorbidities		
Hypertension	0.92 (0.91, 0.93)	<0.0001
Fluid and electrolyte disorders	1.14 (1.13, 1.15)	<0.0001
Chronic pulmonary disease	1.1 (1.09, 1.11)	<0.0001
Congestive heart failure	1.14 (1.13, 1.15)	<0.0001
Deficiency anemias	1.12 (1.11, 1.14)	<0.0001
Any other ^c	1.07 (1.05, 1.08)	<0.0001
Diabetes without chronic complications	0.96 (0.95, 0.97)	<0.0001
Valvular disease	1.07 (1.06, 1.08)	<0.0001
Hypothyroidism	1.02 (1.01, 1.03)	0.0010
Renal failure	1.11 (1.1, 1.12)	<0.0001
Peripheral vascular disease	1.07 (1.05, 1.08)	<0.0001
Other neurological disorders	0.99 (0.98, 1)	0.130
Depression	1.04 (1.02, 1.05)	<0.0001
Diabetes with chronic complications	1.04 (1.03, 1.06)	<0.0001
Obesity	0.99 (0.98, 1.01)	0.510
Pulmonary circulation disease	1.07 (1.05, 1.09)	<0.0001
Weight loss	1.04 (1.03, 1.06)	<0.0001
Solid tumor without metastasis	0.98 (0.97, 1)	0.030
Coagulopathy	1.11 (1.09, 1.13)	<0.0001
Metastatic cancer	1.33 (1.3, 1.36)	<0.0001
Duration of index hospitalization, mean (SD)		
0–2 days	1 (Reference)	
3–4 days	1.13 (1.11, 1.14)	<0.0001
5–6 days	1.3 (1.29, 1.32)	<0.0001
≥7 days	1.65 (1.63, 1.66)	<0.0001
Nursing home stay within 30 days prior to index hospitalization	1.06 (1.05, 1.07)	<0.0001
Disabled	1.01 (0.98, 1.04)	0.670
<i>Index hospital characteristics</i>		
Average annual total discharge count, mean (SD)		
>10,000 annual discharges	1 (Reference)	
7001–10,000 annual discharges	0.99 (0.98, 1)	0.28

(continued)

APPENDIX TABLE 2. (CONTINUED)

<i>Characteristic</i>	<i>Adjusted HR (95% CI)</i>	<i>P-value</i>
4001–4000 annual discharges	1 (0.99, 1.01)	0.19
< 4000 annual discharges	1 (0.99, 1.01)	0.90
Medical school affiliation		
None	1 (Reference)	
Minor	1 (0.99, 1.01)	0.640
Major	1.06 (1.05, 1.07)	< 0.0001
RUCA		
Urban core area	1 (Reference)	
Suburban area	1.02 (0.99, 1.06)	0.140
Large town area	0.99 (0.98, 1.01)	0.340
Small town and isolated rural area	1.08 (1.04, 1.13)	< 0.0001
Critical access hospital	1.06 (0.99, 1.14)	0.080

CI, confidence interval; HCC, Hierarchical Condition Categories; HR, hazard ratio; RUCA, Rural/Urban Commuting Area Code.

^aLocal hospice utilization is defined as the percentage of patients that died who had entered into hospice care within each Hospice Service Area. See text for details.

^bCensus block group from the 2000 U.S. Census.

^cIncludes alcohol abuse, chronic blood loss anemia, drug abuse, liver disease, lymphoma, paralysis, peptic ulcer disease with bleeding, psychoses, rheumatoid arthritis/collagen vascular disease.

APPENDIX TABLE 3. RELATIONSHIP BETWEEN LOCAL HOSPICE UTILIZATION, HOSPICE ENROLLMENT, AND 30-DAY REHOSPITALIZATION, ADJUSTED FOR PATIENT CHARACTERISTICS, MEDICAL HISTORY, AND INDEX HOSPITAL CHARACTERISTICS (N=1,725,043)

<i>Characteristic</i>	<i>Adjusted HR (95% CI)*</i>	<i>P-value</i>
Hospice enrollment	0.12 (0.12, 0.13)	< 0.0001
Local Hospice utilization ^a		
High	1 (Reference)	
Medium	1.01 (1, 1.02)	0.1230
Low	1.04 (1.03, 1.05)	< 0.0001
<i>Patient sociodemographic characteristics</i>		
Age, mean (SD)		
65–69 years	1 (Reference)	
70–74 years	1 (0.98, 1.02)	0.970
75–79 years	1.01 (1, 1.03)	0.170
80–84 years	1.03 (1.02, 1.05)	< 0.0001
≥ 85 years	1.05 (1.04, 1.07)	< 0.0001
Gender		
Male	1 (Reference)	
Female	0.93 (0.92, 0.94)	< 0.0001
Race		
White	1 (Reference)	
Black	1.07 (1.05, 1.08)	< 0.0001
Other	0.99 (0.96, 1.01)	0.170
Medicaid enrollment	1 (0.99, 1.01)	1.0
Percentage of adults age ≥ 25 with at least a high school diploma in patient's census block group ^b	0.86 (0.82, 0.9)	< 0.0001
Percentage below poverty level in patient's census block group ^b	1.01 (0.95, 1.07)	0.860
<i>Patient medical history</i>		
Community HCC score prior to hospitalization, mean (SD)		
1st quartile (mean=0.75)	1 (Reference)	
2nd quartile (mean=1.56)	1.3 (1.29, 1.32)	< 0.0001
3rd quartile (mean=2.67)	1.59 (1.57, 1.61)	< 0.0001
4th quartile (mean=5.15)	1.96 (1.93, 1.99)	< 0.0001
Elixhauser comorbidities		
Hypertension	0.92 (0.91, 0.93)	< 0.0001
Fluid and electrolyte disorders	1.14 (1.13, 1.15)	< 0.0001
Chronic pulmonary disease	1.1 (1.09, 1.11)	< 0.0001
Congestive heart failure	1.14 (1.13, 1.15)	< 0.0001
Deficiency anemias	1.12 (1.11, 1.14)	< 0.0001

(continued)

APPENDIX TABLE 3. (CONTINUED)

Characteristic	Adjusted HR (95% CI)*	P-value
Any other ^c	1.06 (1.05, 1.07)	<0.0001
Diabetes without chronic complications	0.96 (0.95, 0.97)	<0.0001
Valvular disease	1.07 (1.06, 1.08)	<0.0001
Hypothyroidism	1.02 (1.01, 1.03)	0.0030
Renal failure	1.11 (1.09, 1.12)	<0.0001
Peripheral vascular disease	1.06 (1.05, 1.07)	<0.0001
Other neurological disorders	1 (0.99, 1.01)	1.0
Depression	1.04 (1.02, 1.05)	<0.0001
Diabetes with chronic complications	1.03 (1.02, 1.05)	<0.0001
Obesity	0.99 (0.97, 1)	0.070
Pulmonary circulation disease	1.07 (1.06, 1.09)	<0.0001
Weight loss	1.05 (1.04, 1.07)	<0.0001
Solid tumor without metastasis	0.99 (0.97, 1.01)	0.180
Coagulopathy	1.11 (1.1, 1.13)	<0.0001
Metastatic cancer	1.44 (1.41, 1.47)	<0.0001
Duration of index hospitalization, mean (SD)		
0–2 days	1 (Reference)	
3–4 days	1.13 (1.12, 1.14)	<0.0001
5–6 days	1.31 (1.3, 1.33)	<0.0001
≥7 days	1.67 (1.65, 1.69)	<0.0001
Nursing home stay within 30 days prior to index hospitalization	1.08 (1.07, 1.1)	<0.0001
Disabled	1 (0.97, 1.03)	0.90
<i>Index hospital characteristics</i>		
Average annual total discharge count, mean (SD)		
>10,000 annual discharges	1 (Reference)	
7001–10,000 annual discharges	0.99 (0.98, 1.01)	0.22
4001–4000 annual discharges	1 (0.99, 1.01)	0.35
<4000 annual discharges	1 (0.99, 1.01)	0.77
Medical school affiliation		
None	1 (Reference)	
Minor	1 (0.99, 1.01)	0.620
Major	1.06 (1.05, 1.07)	<0.0001
RUCA		
Urban core area	1 (Reference)	
Suburban area	1.02 (0.99, 1.06)	0.120
Large town area	1 (0.98, 1.01)	0.620
Small town and isolated rural area	1.09 (1.05, 1.14)	<0.0001
Critical access hospital	1.06 (0.99, 1.14)	0.090

CI, confidence interval; HCC, Hierarchical Condition Categories; HR, hazard ratio; RUCA, Rural/Urban Commuting Area Code.

^aLocal hospice utilization is defined as the percentage of patients that died who had entered into hospice care within each Hospice Service Area. See text for details.

^bCensus block group from the 2000 U.S. Census.

^cIncludes alcohol abuse, chronic blood loss anemia, drug abuse, liver disease, lymphoma, paralysis, peptic ulcer disease with bleeding, psychoses, rheumatoid arthritis/collagen vascular disease.

APPENDIX TABLE 4. RELATIONSHIP BETWEEN HOSPICE ENROLLMENT, LOCAL HOSPICE UTILIZATION, AND 30-DAY REHOSPITALIZATION USING THE FINE & GRAY PROPORTIONAL HAZARDS METHOD WITH DEATH AS A COMPETING RISK^a (N=1,725,043)

Characteristic	Adjusted HR (95% CI) ^b	P-value
Local hospice utilization		
High	1 (Reference)	
Medium	1.01 (0.995, 1.015)	0.310
Low	1.03 (1.02, 1.04)	<0.001
Hospice enrollment	0.074 (0.07, 0.08)	<0.001

CI, confidence interval; HR, hazard ratio.

^aAdjusted for age, gender, race, Medicaid enrollment, percentage of adults age ≥25 with at least a high school diploma in patient's census block group, percentage below poverty level in patient's census block group, community HCC score, Elixhauser comorbidities, duration of index hospitalization, nursing home stay within 30 days prior to hospitalization, presence of disability, average annual hospital discharge count, medical school affiliation, RUCA, and critical access hospital.

^bReported HRs are the ratios of the subdistribution hazard for rehospitalization in the presence of the covariate to the subdistribution hazard without the presence of the covariate defined by the cumulative incidence function. See text for details.